CK6010

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FLORISTIC AND VEGETATIONAL STATUS OF PITCH AND TAR SWAMP, JAMESTOWN ISLAND

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January 1984

ACKNOWLEDGEMENTS

The author is deeply grateful to Drs. Donna and Stewart Ware, on whose field experience, wisdom, and advice much of this study is based.

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ABSTRACT

To determine whether changes are occurring or imminent in the flora and vegetation of the western three acres of Pitch and Tar Swamp on Jamestown Island, the area's water, soil, and vascular plant community were analyzed. Both the water and soil solution were found to be moderately brackish, the former ranging from 4.1-9.8 parts per thousand salinity and the latter from 1382-6400 parts per million soluble salts. An inventory and classification of the vascular plants yielded 105 species, 51 from routinely inundated areas in the marsh and 55 from the margins or from obvious hummocks. The majority of species in the first category are characteristically or commonly found in brackish marshes, with the only significant vegetational anomaly being seedlings of <u>Acer rubrum</u> (red maple) growing in partially inundated areas. The majority of species in the second category are usually found in low wooded areas or in the transition zone between salt- or brackish marshes and uplands. Twenty-six species found in this study were not recorded in Loetterle's 1970 flora of Jamestown Island, although the newly recorded species do not suggest that moisture or salinity levels have changed significantly in the intervening 13 years. However, the red maples on hummocks and in areas of lower relief near the footbridge to the Visitor Center may be increasing in number, despite evidence that the soil and water conditions are inhospitable to most of the trees in the area. Further study of the red maple population is recommended before eradication measures are undertaken.

INTRODUCTION

Despite its name, Pitch and Tar Swamp is not a true swamp, that is, a fully wooded wetland but rather one of the largest marshes on Jamestown Island. The National Park Service is concerned that the western end of Pitch and Tar Swamp, the section traversed by the footbridge to the Visitor Center, might be changing in its floristic and vegetational composition. Of particular concern is the presence of *Acer rubrum* (red maple) seedlings and saplings within the marsh, perhaps implying that the area is becoming drier or that the water inundating the area is becoming less saline. The purpose of this investigation was to detect and predict any changes in the marsh by analyzing primarily its vascular plant community and secondarily its soil and water. A corollary purpose was to recommend appropriate management techniques if needed to maintain the present character of the marsh.

An inventory and classification of the vascular plants within the marsh and on its margins were made during the growing season from June 1983 through November 1983 and measurements and estimates were made of the ages of the trees established in the marsh proper. Since Loetterle's work on the flora of Jamestown Island (1970) presumably encompassed the flora of Pitch and Tar Swamp, a comparison between her checklist of species and that generated by the present study was made to assess any floristic changes that may have occurred in the intervening 13 years. Comparisons were also made between the plant associations in Pitch and Tar Swamp and those reported as occurring in marshes along the Upper Patuxent River in Maryland (Anderson 1962), those generally found along rivers emptying into the Lower Chesapeake Bay (Wass *et al*. 1972), and those found more generally still in tidal wetlands of Virginia (Boon *et al*. 1977, and Marcellus *et al*. 1973). Soil samples were taken at various locations and analyzed as to soluble salt content, and the salinity of the water was tested in each of three locations on three different dates. These analyses of the soil, water, and vascular plant community of the study area serve not only as an assessment of its current vegetational and floristic status but also as a basis for predicting future trends, barring major physical changes.

DESCRIPTION OF THE STUDY AREA

The area under investigation is the westernmost portion of Pitch and Tar Swamp on Jamestown Island, including approximately one acre of wetland to the west of the footbridge to the Visitor Center and two acres of wetland to the east (as outlined on the map of Jamestown Island -- Figure 1). A dirt road serves as the western boundary of the area, corresponding roughly to the point at which tidal influence becomes insignificant. About 200 meters east of the dirt road, the tidal channels widen and merge, forming an expanse of open water that serves as the eastern boundary. Immediately to the north and south are strips of mixed pine-deciduous woods; beyond them to the north are paved parking lots and to the south, the Visitor Center and other Park buildings and grounds. Field investigations within these boundaries were further confined to regions that were periodically covered by, surrounded by, or adjacent to water throughout most of the growing season. In general terms, the study area can be characterized as a marsh, though the presence of woody species on hummocks within the marsh proper and the inundation of woodlands on the perimeters of the marsh perhaps account for the name Pitch and Tar Swamp.

METHODS

Three types of investigation were performed: water analysis, soil analysis, and collection and identification of the area's vascular plants. Salinity of the water at each of three locations was measured on three dates: 3 September, at or near low tide after a fairly prolonged drought; 25 September, at or near high tide after heavy rains the preceding week; and 6 November, at or near low tide after two weeks of moderate rainfall. A hydrometer was used to measure the specific gravity of the water samples, and salinity was determined therefrom by means of standard conversion tables.

Soil samples were taken in five locations and analyzed for total soluble salt content by the Cooperative Extension Service Soil Testing and Plant Analysis Laboratory, Virginia Polytechnic Institute and State University. The results were compared with the salt content of previously sampled salt marsh soil and swamp woods soil from other sites in Virginia's Coastal Plain.

Plant collecting trips to the study area were made approximately biweekly from June 1983 through November 1983. Specimens of all vascular plants were collected, identified either in the field or subsequently in the laboratory, and annotated as to location and relative abundance. A voucher set of specimens is to be deposited at the Herbarium of The College of William and Mary and a duplicate set is to be made available to the National Park Service. Plant species also were categorized according to the habitats in which they typically are found (e.g., freshwater marsh) on the basis of the author's own field experience and that of D.M.E. Ware, Curator of the Herbarium at the College of William and Mary and by consulting one or more of the following works: Anderson (1962), Boon *et al*. (1978), Fernald (1950). Gleason and Cronquist (1963), Marcellus *et al*. (1973), and Wass *et al*. (1972). Core samples were taken of a few of the largest red maples and loblolly pines (*Pinus taeda*) on hummocks within the marsh to arrive at an estimate of the age of the oldest trees.

RESULTS OF WATER ANALYSIS

Water is classified as brackish if its salinity falls generally between 5 and 25 parts per thousand (Sumich 1980, p. 4). According to Anderson's study of the Upper Patuxent (1962), readings over 0.4 ppt indicate the intrusion of salinity into fresh water. As can be seen in Table 1, the water inundating the study area is moderately brackish, varying in salinity according to tide and weather. The highest salinities were recorded at or near low tide on 3 September and 6 November; it should also be noted that the two months preceding the first date had very little rainfall. The lowest salinities were recorded at or near high tide on 25 September after a week of moderately heavy rain. No record is available for the western limit of the study area on 6 November because of equipment failure.

While field work did not quantitatively assess tidal fluctuations, visual observations of water levels at both high and low tides were made throughout the season. Tidal flooding was always apparent, although during low tide in late July, August, and early September the flow was reduced to narrow channels in higher areas of the marsh, including the area near the footbridge. After Hurricane Dean, in the first week of October, standing water was observed to cover even the highest hummocks in the marsh.

TABLE 1

RESULTS OF WATER ANALYSIS

LOCATION	SALINITY (parts per thousand)		
	9/3/83	9/25/83	11/6/83
Near footbridge	9.8	4.6	9.2
E limit of study area	6.4	6.3	9.6
W limit of study area	8.2	4.1	no record

RESULTS OF SOIL ANALYSIS

Table 2 gives the results of the soil analysis. By themselves the data are unrevealing, but they become more meaningful when compared to data taken from other Coastal Plain locations. The soluble salt content of sample # 2 is not only high relative to that of other samples from the study area, but it is comparable to the salt content of saltmarsh soil sampled in Middlesex County, Virginia (North 1983). The other values, when represented in parts per thousand (e.g., 3456 ppm = 3.456 ppt) are in line with what would be expected from soils in a brackish marsh.

Since the establishment and success of red maples and other trees customarily found in swamps are at issue here, it is useful to compare these data with the soluble salt content of soils in undisturbed swamps in Virginia's Coastal Plain. Fifteen swamp stands were sampled by Parsons and Ware (unpub. data), yielding values ranging from 0 to 179 ppm, with a mean of 55. In the study area, then, the soil has a soluble salt content from 8 to 35 times higher than the highest salt content of soils where red maples and the other deciduous trees encountered in the area are most typically found.

TABLE 2

RESULTS OF SOIL ANALYSIS

LOCATION	SOLUBLE SALTS (parts per million)
1) Root zone of *Spartina patens*, W limit of study area	1920
2) Root zone of *Acer rubrum* seedlings, near footbridge	6400
3) Depth of 0.5 meter, hummock E of footbridge	3456
4) Depth of 0.5 meter, inundated area at center of marsh	2048
5) Depth of 0.5 meter, E limit of study area	1382

which are locally abundant or widely distributed throughout the marsh. Five typically brackish species collected in this study were not reported by Loetterle (1970) as occurring on Jamestown Island, three of them from the preceding list: Cyperus odoratus, Panicum virgatum, and Spartina patens. Since the presence of the first two would be hard for a worker in the field to overlook, it is likely that they have colonized the area rather rapidly since 1970. The third species, Spartina patens, might have gone unrecorded by Loetterle because, while abundant, it is represented chiefly by sterile plants. Its presence here is somewhat anomalous since it is usually found in association with Distichlis spicata in high saltmarshes, where the water ranges from 10-17 ppt salinity (Wass et al. 1972, p. 48). It may have become established at a time when water in the area was more brackish and is now persisting despite salinity levels lower than its usual range (D.M.E. Ware, pers. comm.).

Sixteen species (31.37% of the total collected in inundated areas) are not often found in brackish marshes. The majority are represented either by a single individual or colony or by occasional individuals scattered in the marsh. Four species, however, are abundant, at least locally: Lemna perpusilla, Heteranthera reniformis, Mikania scandens, and Thelypteris palustris. Heteranthera reniformis was not reported by Loetterle (1970), and again it is assumed that the species has colonized the area since her work was done. The three other abundant species, while not typical of brackish habitats, were found by Loetterle in or on the margins of brackish marshes on Jamestown Island and have been encountered in similar wetlands in Virginia's Coastal Plain (D.M.E. Ware, pers. comm.).

Seven species, or 13.72% of the total collected in the marsh proper, are customarily found in low wet areas, e.g., bogs or swamps, as distinct from marshes. Only two of these are abundant: Juncus effusus and Hydrocotyle verticillata, both of which are broadly adapted, wide-ranging species, also reported by Loetterle (1970) as occurring in brackish marshes. The red maple seedlings mentioned previously fall into this category, since the tree itself, by definition, is not a regular marsh inhabitant. The seedlings are fairly numerous, particularly in the muddy shallows near the footbridge. According to Wass et al. (1972, p. 58), red maple is the most water tolerant deciduous tree in this region, and it is often the most abundant tree in swamps where the soil is always fully saturated (Parsons and Ware 1982). It is possible that the relative dryness of the summer of 1983 allowed the seedlings to become established in places where they would not be able to grow in years of higher rainfall. Whether the species can thrive in a brackish marsh is a question addressed later in the discussion of the age and condition of trees in the area.

Of the 55 species encountered chiefly on the margins of the marsh or on hummocks, 45, or 81.81% of the total in this habitat, are characteristic of low, usually wooded areas or areas that are transitional between saline or brackish marshes and various types of uplands. The ten remaining species are more commonly found in upland areas, though all of them, with the exception of Diospyros virginiana, can be considered opportunistic and successful in a wide range of habitats. A few upland species, such as Rubus cuneifolius, have taken advantage of higher, drier conditions created locally by fallen, decaying trees. Fifteen species, or 27.27% of the total found in this habitat, were not reported by Loetterle (1970) as growing on Jamestown

Island, but only one of them is more than occasional in occurrence: the grass *Panicum dichotomiflorum*, which is abundant along the border between a mowed field and the marsh at the western end of the study area. One other grass, *Panicum hians*, collected in the same location, is worthy of mention because it represents a northern extension of the range of a species that is listed by the U.S. Fish and Wildlife Service as being threatened in Virginia (Porter 1979).

All of the woody species collected in this study occur on both the margins of the marsh and on hummocks. The shrubs *Baccharis halimifolia* and *Myrica cerifera* are common to abundant, chiefly on hummocks within the marsh and along inlets. Both species are characteristic of the transition zone between saltmarsh and uplands (Boon *et al*. 1978). Loblolly pine is the dominant tree on the margins and the largest on the hummocks; according to Wass *et al*. (1972, p. 65), it is the most salt tolerant native pine. Red maple is by far the most common tree on the hummocks, occasionally joined by *Juniperus virginiana* (red cedar) and rarely by *Ulmus americana* (American elm), *Nyssa sylvatica*, (black gum), *Salix nigra* (black willow), and *Quercus falcata* var. *pagodaefolia* (cherrybark oak). Red cedar is both quite salt tolerant (Wass *et al*. 1972, p. 45) and also commonly found in the transition zone (Boon *et al*. 1978), while the other trees are most typically encountered in swamps or low woods and are not noted for their tolerance of salinity.

AGE AND CONDITION OF TREES

The age, distribution, and condition of the trees within the marsh, both on hummocks and in areas of lower relief, were examined to shed more light on the red maple population. Red maple is the only woody species represented elsewhere in the marsh than on obvious hummocks, but in areas of lower relief it is present only in the seedling stage. The larger red maples, like members of the other woody species, are confined to hummocks, where they are not only the most common but also the largest and, by inference, the oldest deciduous trees present. Core samples were taken of the two largest red maples, one to the west and one to the east of the footbridge, and they proved to be 15 and 12 years old respectively. A core taken from the largest loblolly pine, on a hummock approximately 20 meters east of the footbridge, indicated the tree to be 22 years old. These are estimated to be the oldest living trees within the marsh, with the preponderance of the remaining trees, both deciduous and coniferous, estimated to be under ten years old.

Two hypotheses could account for this age structure: either conditions in the area are such that trees cannot survive beyond 15-20 years, or the area has become suitable for trees only in the last 15-20 years or so. There is some evidence to support the former hypothesis. Of the deciduous trees on hummocks within the marsh, only red maple seems to be relatively healthy and perhaps increasing in number. All individuals of American elm, black willow, and cherrybark oak show signs of stress ranging from discolored, diseased foliage to dead limbs and dead crowns. Of the coniferous trees, the only large red cedar has discolored foliage, and the loblolly pines, while apparently healthy for the most part, are neither numerous on the hummocks nor obviously increasing in number. Other evidence in support of the first hypothesis is the existence of several recently and not-so-recently uprooted trees, in approximately the same size-range as the living trees, scattered throughout the wooded portion of the area, particularly in the 20 meters east of the footbridge. During the course of this study, a number of red maples estimated to be five to ten years old were observed to become uprooted. While the signs of stress exhibited by many of the trees could indicate intolerance of either the salinity or the level of the water, the uprooted trees suggest that the latter factor may be more important. The influence of tides and occasional heavy flooding (such as was observed after Hurricane Dean) may cause the soil to be too unstable to support trees larger than those currently established in the area. It should be pointed out that both leaf litter and the uprooted trees themselves, if not flushed away by tides, contribute to the building of hummocks within the marsh and thus improve conditions for further colonization by woody species. However, this trend may be counterbalanced or even outweighed by the general rise in sea level that has been observed in the region in the last 50 years (Wass et al. 1972).

The second hypothesis, that conditions within the marsh have only recently allowed the growth of trees, is difficult to support or dismiss without ageing the dead timber and analyzing the sediments for plant remains. The area extending a few meters west and approximately 20 meters east of the footbridge is higher in relief than the surrounding marsh, and it is possible that earth-moving during construction of the bridge may have caused some local erosion, raising the level of the land in the marsh nearby and making it more hospitable to trees. While a knowledge of the past history of woody species in the area would be helpful, there are more direct methods of predicting future trends, to be discussed in the following section.

CONCLUSION AND RECOMMENDATIONS

Both the water and the soil solution in the study area are moderately brackish, the former ranging from 4.1-9.8 ppt salinity and the latter from 1382-6400 ppm soluble salts. By definition and by nature, brackish marsh plant communities fall somewhere in between their salt- and freshwater counterparts. The species inhabiting Pitch and Tar Swamp are a diverse group, varying in salinity tolerances from *Spartina patens*, most commonly found in areas of 10-17 ppt, to *Pontederia cordata*, found almost exclusively in freshwater marshes (Marcellus *et al*. 1973). In general, the most successful species in the area are, like *Spartina cynosuroides*, inhabitants of brackish marshes seemingly by preference or, like *Juncus effusus*, adapted to a wide range of environmental conditions. While 26 species, or 24.76% of all the species found in this study were not reported by Loetterle (1970) as occurring on Jamestown Island, only a few are of vegetational significance, and none point to significant changes in either moisture or salinity levels.

The area to the east of the footbridge, higher in relief than the surrounding marsh, may be in the process of colonization by red maples. However, the ultimate success of these trees is uncertain due to the brackishness of the water and the instability of the repeatedly inundated soil. Since red maples send up sprouts from cut stumps, they could be easily and effectively eliminated only by rather drastic techniques, such as flooding by impoundment, that would eliminate all the other woody species and perhaps alter the herbaceous plant community as well. Before resorting to these measures, it would be sensible to obtain quantitative measurements of the red maples' growth and change in number over time. To this end, it is recommended that permanent quadrats be established within which all red maples, including seedlings, should be counted for a number of years. The requirements for the quadrats are fairly simple: the wooded area in the marsh east of the bridge could accommodate three or four 10-meter square quadrats, drawn to include at least some extant red maples, and demarcated by tagging corner trees or by measuring from nearby landmarks. Obviously, the longer the quadrats could be observed, the more information would be obtained, but it should be apparent within a few years whether more trees are becoming established than are dying or becoming uprooted. It is also recommended that a random selection of the largest red maples be monitored and measured (diameter at breast height) each year for a number of years to determine whether large trees can thrive in the area. A further recommendation is that sizeable uprooted trees be removed from the marsh near the footbridge to prevent new hummocks from being created by the accumulation of dead timber. Should the red maple population prove to be thriving and increasing, eradication procedures may then be considered. There is no urgency, however, for two reasons: first, it is much more likely that the red maples are responding to rather than responsible for changes in the area, and second, red maples of any size can be killed at any time by induced flooding of sufficient depth and duration. It should also be remembered that the island is subject to occasional natural flooding that may, sooner or later, eliminate many of the area's woody plants without any help from man.

PREFACE TO CHECKLIST

There are 105 species in the checklist that follows, grouped according to habitat in which they were collected. An asterisk preceding the species name indicates that the species was not reported by Loetterle (1970) as occurring on Jamestown Island. Species nomenclature follows Radford *et al.* (1968). Common names appear after the Latin names only when their usage is widely accepted, as determined by their citation in Fernald (1950) and/or Radford *et al.* (1968). After the species name in parentheses are a number indicating abundance and a letter or letters indicating habitat(s) in which the species is commonly found, as explained in the following key.

ABUNDANCE SCALE

5 --- abundant

4 --- common

3 --- occasional

2 --- uncommon

1 --- rare

HABITAT ABBREVIATIONS

B - Brackish marshes

F - Freshwater marshes

S - Saltmarshes

L - Low areas, including swamps, bogs, and shores

U - Uplands, including dry to mesic fields and woods

T - Transition zone between salt- or brackish marshes and uplands

CHECKLIST OF SPECIES

I. INUNDATED AREAS

WOODY SPECIES

Acer rubrum. Red maple (4, L)

HERBACEOUS SPECIES

Amaranthus cannabinus. Water-hemp (1, B)

Asclepias incarnata. Swamp milkweed (1, B,F,L,T)

Aster novi-belgii. New York aster (3, B,F)

A. subulatus (3, B)

Bidens laevis (1, F,B)

**B. polylepis* (3, F,L)

Boehmeria cylindrica. Bog-hemp (3, F,L,T)

Carex alata (3, F,L)

**C. stipata* (2, F,L)

Cicuta maculata. Water hemlock (2, F,L)

**Cyperus filicinus* (2, B,L)

**C. odoratus* (5, F,B,L)

Decodon verticillatus. Swamp-loosestrife (2, F,L)

Echinochloa walteri (5, F,B)

Eleocharis fallax (5, B)

**E. parvula* (3, B,F)

Erianthus giganteus (3, L)

**Heteranthera reniformis*. Mud-plantain (5, F,L)

Hibiscus moscheutos. Rose-mallow (3, B,F)

Hydrocotyle verticillata (5, L)

Iris virginica. Southern blue flag (2, F,L)

Juncus effusus. Soft rush (5, L)

Kosteletskya virginica. Seashore-mallow (3, B,T)

*Leersia oryzoides. Rice-cutgrass (3, F)

Lemna perpusilla. Duckweed (5, F,L)

Lippia lanceolata. Fog-fruit (5, F,B)

Ludwigia alternifolia. Seedbox (1, F,L)

*L. decurrens (3, F,L)

Mikania scandens. Climbing hempweed (5, F,L,T)

*Panicum virgatum. Switchgrass (5, U,B,T)

Peltandra virginica. Tuckahoe (1, F)

Pluchea purpurascens. Camphorweed (4, B)

Polygonum arifolium. Halberd-leaved tearthumb (5, F,B)

P. punctatum. Water-smartweed (5, L,B)

P. sagittatum. Arrow-leaved tearthumb (1, F,B)

Pontederia cordata. Pickerelweed (3, F,L)

Ptilimnium capillaceum (3, F,B)

Ranunculus sceleratus (3, F,B)

Rosa palustris. Swamp rose (3, L)

Rumex verticillatus. Swamp dock (2, L)

Sagittaria falcata (4, F,B)

Samolus parviflorus. Water pimpernel (3, F,B,T)

Scirpus americanus. Three-square (4, B,F,T)

S. validus. Great bulrush (5, B,F)

Spartina cynosuroides. Giant cordgrass (5, B,T)

*S. patens. Salt-meadow grass (5, S,B,T)

Spiranthes cernua. Nodding ladies'-tresses (2, L)

Thelypteris palustris. Marsh fern (5, F,L)

Typha angustifolia. Narrow-leaved cattail (5, B,F)

T. latifolia. Common cattail (5, F,B)

II. MARGINS AND/OR HUMMOCKS

WOODY SPECIES

TREES

Acer rubrum. Red maple (4, L)

**Cornus stricta*. Swamp dogwood (1, L)

Diospyros virginiana. Persimmon (3, U)

Fraxinus pennsylvanica. Red ash (4, L)

Juniperus virginiana. Red cedar (4, U,T)

Nyssa sylvatica. Black gum (2, U,L)

Pinus taeda. Loblolly pine (5, U,L)

Quercus falcata var. *pagodaefolia*. Cherrybark oak (2, L)

Salix nigra. Black willow (1, L)

Ulmus americana. American elm (3, L)

SHRUBS

Baccharis halimifolia. Groundsel-tree (4, T)

Myrica cerifera. Wax-myrtle (5, U,L,T)

VINES

Campsis radicans. Trumpet-creeper (3, U,L)

Rhus radicans. Poison ivy (4, L,U,T)

Smilax rotundifolia. Common greenbrier (3, U)

Vitis sp. Wild grape (3, U,L)

HERBACEOUS SPECIES

Allium canadense. Wild garlic (2, L)

Anthoxanthum odoratum. Sweet vernal grass (2, U)

Apios americana. Groundnut (3, L,U)

Arthraxon hispidus var. cryptatherus (4, U)

Asparagus officinalis. Asparagus (2, U,T)

*Carex festucacea (3, L)

*C. frankii (2, L)

*C. lupulina (2, L)

C. lurida (2, L)

C. vulpinoidea (3, L)

Cinna arundinacea. Wood reed (2, L)

Cyperus ovularis (3, L)

*C. polystachyos var. texensis (5, L)

*C. strigosus (3, L)

Diodia virginiana. Buttonweed (4, L)

Eclipta alba (3, L)

*Eleocharis obtusa (4, L)

Elymus virginicus. Wild rye grass (2, U,L,T)

Erechtites hieracifolia. Fireweed (2, U,T)

Festuca elatior (3, U)

*Galium obtusum (4, L)

G. tinctorium (4, L)

Holcus lanatus. Velvet grass (2, U)

Juncus acuminatus (4, L)

J. coriaceous (3, L)

*Leersia virginica (2, L)

Osmunda regalis. Royal fern (3, L,T)

*Panicum agrostoides (3, B,L)

*P. dichotomiflorum (5, L)

*P. hians (2, L)

*Paspalum laeve (3, U)

Pluchea foetida. Stinking fleabane (2, L)

Poa compressa. Canada bluegrass (5, U)

*Rhynchospora caduca (2, L)

*Rubus cuneifolius. Blackberry (2, U)

Rumex conglomeratus (3, L)

R. crispus. Yellow dock (3, U)

*Sisyrinchium mucronatum. Blue-eyed grass (1, F)

Solidago sempervirens. Seaside goldenrod (4, B,T)

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